REFLECTING MATERIAL

The present invention refers to a material for thermoforming as well as to the use of this material for the manufacturing of a reflecting product by means of thermoforming.

While performing different activities during more or less bad lighting, it is important for a person performing the activities to be completely visible. At present, a person can obtain a lower degree of protection by different types of reflex tapes, so as to be visible during poor light conditions. This does not only apply to different types of spare time activities, such as bicycling and horse riding, but also to activities related to employment, such as for instance firemen and policemen, which have to protect themselves with adequate reflector means when working professionally under conditions with low levels of lighting. In this connection a "reflector means" accomplishes a reflection in which light is reflected in directions close to the direction from which it came.

In the nowadays existing traffic environment, it is especially important to protect the head, and this applies to children as well as grown-ups. However, conventional helmets are not easily noticed, for example, by motorists at night, and the user may risk injury from a traffic accident on such occasions even if a helmet is used. In order to alert a motorist under these conditions, several types of reflecting warning signs, which are visible at night, are now commercially available.

Ordinary plane reflector means, however, have a limited protecting effect by only emitting light when struck by light from only one direction. It is true that different kinds of adhesive reflecting tapes exist which can be fastened for example on clothes or helmets. However, a self-adhesive material, such as a sticker, cannot be

applied to a curved surface due to the formation of wrinkles. On the same grounds, it can neither be applied to a material in the form of a sheet which subsequently is fixed onto a curved surface by means of thermoforming, since the material then will crack or crackle. Due to the above mentioned problems, reflecting materials according to the state of the art rapidly loose their reflecting properties when applied to irregular or curved surfaces.

The purpose of the invention is thus to provide a reflecting material which can be used both as a reflecting plane sheet per se and as a material for thermoforming, preferably by means of vacuum forming, to a curved or irregular surface, the material retaining its reflecting property without crack formation or cracking. In order to achieve this purpose, the invention has obtained the characterizing features of claim 1 and its use has obtained the characterizing features of claim 16.

In order to explain the invention in more detail, reference is made to the accompanying drawing, in which

FIG 1 schematically shows a cross section through a reflecting material in the form of a sheet according to the invention,

FIG 2 schematically shows a cross section through a further development of the embodiment of the material according to the invention, which is shown in FIG 1,

FIG 3 schematically shows a cross section through an alternative embodiment of the material according to the invention, and

FIG 4 schematically shows a cross section through a material according to a preferred embodiment of the invention.

In FIG 1 the material according to the invention is shown in its most simple form, and consists of a plane sheet 1 which is coated with a reflecting layer 2. The sheet 1 can be of every type of plastic material. However,

it is preferred that the sheet comprises a transparent thermoplastic polymer material, preferably crystal-clear polyvinyl chloride (PVC) or polyester, the polyester being preferred since it is more harmless to the environment.

The reflecting layer 2 comprises a suspension of pearls, for example of glass or plastic, in an adhering substance, preferably a lacquer. In this connection a lacquer means a non-pigmented liquid with an organic film forming substance which can be a natural resin, a synthetic resin or an oil. Preferably a so-called screen printing lacquer is used.

It is an important aspect of the invention that pearls of a certain size are mixed with the adhesive substance. Preferably, the pearls have a diameter between 0.01 and 0.05 mm. The adhesive substance must be able to attach to the plastic at the same time as it shall be able to bind to the pearls. Thus, the adhering substance comprises an etching transparent glue coating. In this connection etching refers to an increase in surface roughness of the plastic by dissolution of the same. After the application of the reflecting layer 2, the adhering substance in the form of a lacquer is hardened, preferably by means of heat, but it can also be hardened in other ways, for example by means of radiation.

In order to obtain a reflecting laminated material according to the invention, the adhering substance and pearls of for example glass or plastic are mixed into a suspension which must have a suitable consistency so that the pearls of microscopic size will be transferred to the plane sheet 1 by means of a known technique in the form of screen printing (silk screen processing). This is a method which normally is used for applying a pattern to a plastic sheet which is to be subjected to thermoforming. The size of the pearls is thus also adapted to be able to pass through the open holes of a screen stencil which normally

is used for pressing a pattern medium against the sheet. When the pearls used are of glass, they must be polished pearls of high quality. The same type of glass pearls as in existing reflecting tapes can be used with advantage. Preferably, the size of the glass pearls lies within the range of 0.01-0.05 mm.

By this procedure, the suspension is anchored on the plane material, a reflecting surface being obtained. The more pearls mixed into the suspension, the better reflectance is achieved. In this connection the amount of glass pearls suspended in the adhering substance in the form of a lacquer could surprisingly comprise as much as 85 %. This results in the consumption of 1 kg glass pearls for covering 4-5 m^2 of the sheet, which after thermoforming for example can be used for shells for about 50 helmets of normal size.

The material according to the invention can in this embodiment also be used for achieving a reflection in two directions, by the reflective layer being applied to both sides of a suitable surface. It is of advantage if this surface is a sheet of plastic material which can be thermoformed. Preferably all kinds of existing materials of polyvinyl chloride (PVC) are used, i.e. all thermoplastic materials which comprise polymers of vinyl chloride. The plane reflecting material can also be used without thermoforming in the form of a traffic sign or another warning sign indicating danger or other circumstances which should be observed by the public.

When the reflective layer 2 has been applied to the sheet 1, other patterns can be printed on the material according to the invention. This is then thermoformed, for example by means of vacuum forming, to a shape corresponding to the curved surfaces, which the shells thus formed are intended to fit. The thermoplastic material according to the invention, in the form of a plane or

flexible sheet or foil of a thickness which is sufficient for vacuum forming, is then heated to its vacuum forming temperature and formed to a general contour of a mould by means of a pressure difference. Thus, vacuum forming is performed by means of known techniques at 130 °C, the material being drawn and stretched to a shell which for example has the shape of a helmet.

After cooling, the thin shells formed are sawn into separate units, and holes are optionally punched out in them. If the shells are to be used in a finished product in the form of a helmet, the shell is finally glued onto an inner helmet which has a protective effect on the head.

The helmet can then, if desired, be built in with a further plastic layer. This can be necessary since the virtual reflection can be reduced, i.e. in humid weather. For this reason a further coating is applied to the finished product, e.g. a layer which protects the reflecting layer and strengthens it even more. As shown in FIG 2, this can be achieved by a further layer 3 of preferably PVC being applied by means of for example high-frequency welding to the reflecting layer 2 which in turn is disposed on the plane sheet 1.

A more cost-efficient embodiment of the invention according to FIG 1 is shown in FIG 3, a plane sheet 1 of preferably a plastic material being used as above, said material being workable by means of vacuum forming. In this embodiment a layer 4a of an adhering substance is disposed on the sheet 1, and a thin layer 5 of pearls is applied to the layer 4a. A further layer 4b of an adhering substance is again disposed over this layer 5 of pearls.

The layers 4a and 4b preferably consist of the same transparent glass-clear adhering substance in the form of a lacquer, the lacquer in the layer 4a being etching as in the previous embodiment.

With reference to FIG 3, the reflecting laminated material is achieved by the etching layer 4a of adhering substance being applied to the sheet 1. Pearls are spread onto this layer before it has dried. This can for example be accomplished mechanically with an equipment which usually is utilised for coating with different kinds of powders. Glass pearls are for example spread in this procedure so that they will fall down onto the still sticky layer 4a, a monolayer of glass pearls contacting the same with non-adhering pearls on the top. The sheet with accompanying layers 4a and 5 is then allowed to pass an oven for curing of the adhering substance in the layer 4a. When this layer has been cured, non-adhering glass pearls can be sucked off and reused. Another layer 4b of adhering substance is then applied to the layer 5 of glass pearls, the sheet with accompanying layers then being allowed to pass the oven again for curing of the layer 4b.

The material according to this embodiment of the invention can also be vacuum formed into a reflecting shell to be applied to a curved surface without any crackle formation taken place during the forming procedure. The reflecting surface is sufficiently well adapted for many applications in order to provide for an efficient reflecting effect.

In FIG 4 an embodiment is shown which is especially preferred when the material according to the invention is to be used for reflecting helmets. By arranging the product in the form of a shell from the material according to the invention for example on the inside of a bicycle helmet, in which holes have been cut out for the reflecting material, the reflecting product can be used where it is more protected from the surrounding world. In this embodiment this can be achieved by a layer of the material according to the invention being arranged on that side of the sheet 1 which in the finished helmet will not be directed towards

the light source, i.e. the sheet 1 acts as a protecting layer for the other layers.

With reference to FIG 4, a colour layer 6 is arranged between the sheet 1 and the layer 4a of an adhering substance. The colour layer 6 comprises a transparent dye known in the art, which can be excluded in dependence of the design and appearance of the final product. The reflecting layer is arranged as in the preceding embodiment in the form of a single layer of pearls, for example of glass or plastic, between two layers, 4a and 4b, of adhering substance. In this connection the adhering substance used should be able to etch dyes as well as plastics.

A layer 7 of a material with high gloss, for example silver or aluminium, is disposed on the layer 4b of adhering substance in order to further amplify the reflection. Preferably, aluminium particles are used. Thus, when the reflecting layer 5 is illuminated, the light not immediately reflected by this layer will be reflected with total reflectance by the layer 7 and re-transmitted towards the observer after reflection by the pearls in the layer 5.

The layer 7 is preferably applied to the laminate according to the invention as a paste of commercial aluminium particles by means of the above-mentioned technique in the form of screen printing.

The reflecting laminated material according to the invention can then be heated to a temperature which is suitable for vacuum forming, e.g. 130 °C, vacuum forming then being performed as described above. The reflecting material in the form of a sheet according to the invention must in this connection have a thickness which is sufficient considering the product contemplated after vacuum forming. The material can for example be vacuum formed into a shell in the form of a helmet which becomes highly reflecting from the outside with the reflecting

layer on the inside of the helmet, the reflecting layer thus being protected against all types of damages. In this way a helmet of impact-resistant plastic can be achieved with reflecting patterns as well as usual patterns, which can result in increased road safety, especially for children.

It should be observed, that a colour layer, if desired, can be arranged in a corresponding way in other embodiments of the invention. In this connection the location of the colour layer in the laminate is not crucial. A dye can also be mixed into the suspension of pearls and adhering substance, a reflection of the corresponding colour then being obtained. In this connection the dyes should also be transparent. Furthermore, it is important that all transparent components in the material according to the invention retain this property after thermoforming, such as vacuum forming.

Warning articles manufactured from the material of the present invention present a reflective construction which is durable, rather cheap and quite visible under poor natural light conditions, especially at night, when the reflecting articles are illuminated by an external active light source, such as a light from a head light of a car. By the vacuum forming property of the inventive material, the invention can be used for increased safety, especially on the roads. Products having an irregular or curved surface can be produced with a functional reflectance when the present invention is used. Thus, all kinds of light reflecting products can be achieved, such as bicycle helmets, protective helmets for building workers and playing children, and so on. Accordingly, the invention can be used as a reflective device with the capability of reflecting light and thus being visible from all angles, i.e. a retro-reflecting device generating a reflection in

all directions and usable on a person as such. Other products for increased road safety can also be obtained by using the invention when a more or less completely reflecting surface is desired, such as hub caps with ornaments and reflective patterns.